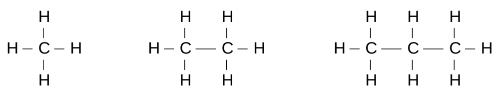
Survival sheet

AS 90932 CARBON CHEMISTRY

Part 1 of 2

Alkanes:

- C_nH_{2n+2}
- Saturated hydrocarbons (each C atom bonded to 4 other atoms; all C to C bonds are single covalent bonds).



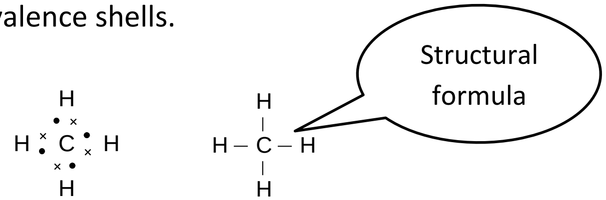
CH_4 methane C_2H_6 ethane C_3H_8 propane

The next members are butane C_4H_{10}, pentane C_5H_{12}, hexane C_6H_{14}, heptane C_7H_{16} and octane C_8H_{18}.

- CNG (compressed natural gas): mostly CH_4.
- LPG (liquid petroleum gas): mostly propane and butane
- Petrol: mixture of hexane, heptane & octane

Bonding and formulae:

The type of bonding is called covalent; the atoms share pairs of electrons to achieve full valence shells.



CH_4

Each — between atoms is a pair of electrons / a covalent bond.

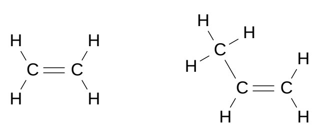
CH_4 is the molecular formula (tells you number and type of each atom).

Melting points & boiling points:

- M.pt. – temp. at which substance changes from s → l; B.pt.is temp. at which substance changes l → g.
- To melt / boil, particles must vibrate or move fast enough become free of the solid, or liquid.
- At room temperature (25°C):
  - Alkanes C1-4 are gases, C5-8 are liquids.
  - Alkenes C2 and C3 are gases.
  - Alcohols C1 and C2 are liquids.
- As the number of C atoms ↑, the mass of the molecule increases AND melting and boiling points ↑. More energy is need to separate particles (melting) and/or for particles to escape the liquid state (boiling).

Alkenes:

- C_nH_{2n}
- Unsaturated hydrocarbons (NOT every C atom is bonded to 4 other atoms; they contain a C=C double bond).



C_2H_4 ethene C_3H_6 propene

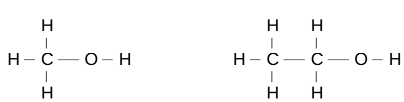
For experts:

As the size of the molecule increases so does the strength of the attractive forces between the molecules.

More energy is required to overcome these weak attractive forces between molecules to allow a change in state.

Alcohols:

- NOT hydrocarbons as they contain oxygen.
- Have an alcohol group –O-H, sometimes simply written as –OH.



CH_3OH methanol C_2H_5OH ethanol

Fermentation:

Conditions: Yeast acts as a catalyst, needs a warm temperature (25-35°C), and anaerobic conditions / lack of oxygen.

Glucose molecules are converted by the enzymes in yeast, into ethanol and carbon dioxide molecules in anaerobic conditions / without O_2.

Equation: $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$

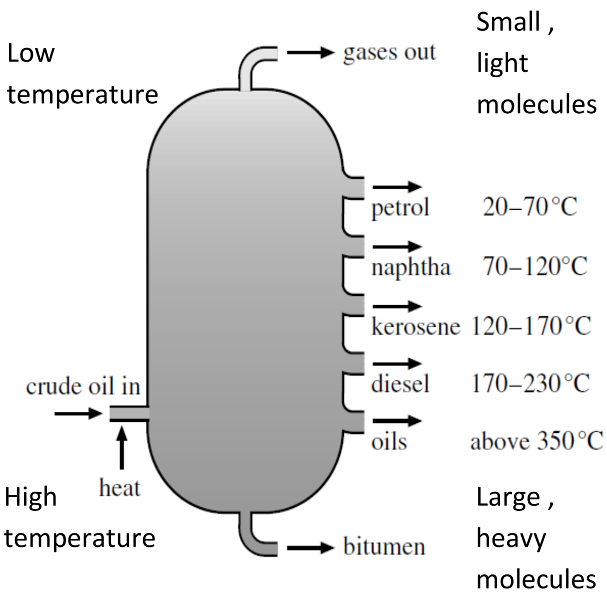
Solubility in water:

- Alkanes and alkenes are <u>all</u> insoluble in water; Immiscible liquids do not mix, but separate into two distinct layers when placed in the same container.
- Methanol and ethanol are both completely soluble in water.

Part 2 of 2

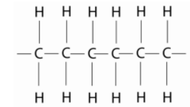
Crude Oil: Fractional distillation

- Crude oil - mixture of hydrocarbon molecules of different sizes.
- Hydrocarbons of different molecular masses have different B.pts. and are separated by fractional distillation; The molecular mass determines where on the tower the particular fraction is collected.
- Heated crude oil vapour enters the tower.
- Larger, heavier hydrocarbons – more C atoms (with higher B.pts.) condense into liquids lower down the tower.
- Smaller, lighter hydrocarbons - less C atoms (with lower B.Pts.) rise up the tower and condense into a liquid at the lower temperatures near the top of the tower.
- The smallest hydrocarbons (C1 – C4) remain as gases.

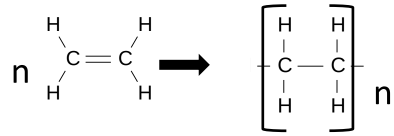


Polymers: made from alkenes, ethene and propene

Poly(ethene): Many small ethene molecules (monomers) are joined together to form long-chain molecules.

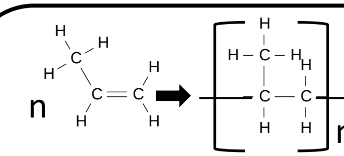


Poly(ethene) uses: plastic bags, cling wrap, squeeze bottles.



The chemical reaction requires heat, pressure & catalyst to speed it up

- The (covalent) double bond between each carbon atom in ethene is broken and single bonds formed between the carbon atoms, forming long carbon chains.
- Poly(ethene) is tough as it consists of many strong, long chain, molecules which overlap each other, to form sheets.
- Suitable for food containers as it has low chemical reactivity (chemical property) and can be heated & moulded into shapes (physical property).



Poly(propene): made from propene monomers. **Uses**: food containers, fibres, ropes, pipes. Good for ropes used in water, as low density and floats (physical property) and has low reactivity with air/water (chemical property).

Combustion: (burning; an oxidation reaction).

The alkanes, alkenes and alcohols will all burn (are flammable), and alkanes & alcohols are useful as fuels. The alkenes are too valuable to waste as fuels as they can be made into plastics.

Complete combustion: in plentiful O_2 supply, producing CO_2 and H_2O products; clean almost invisible flame. Sufficient oxygen present for all the carbon atoms to react with O_2 to form CO_2.

Incomplete combustion: in limited O_2; not enough oxygen present in the air for all of the carbon atoms to turn into carbon dioxide.

Shown by a yellow flame, producing C (soot), CO and H_2O as products

Energy released: Complete combustion is a more efficient producer of energy than incomplete combustion.

Effects of combustion products human health & the environment:

- **Carbon** particles cause air pollution - coat buildings, affect plants, and human health, (respiratory problems including asthma and lung cancer), can scatter solar radiation & reduce the efficiency of photosynthesis
- **CO (carbon monoxide)** is a colourless, odourless and highly toxic gas. CO forms a stable compound with haemoglobin – prevents O_2 from being carried to the parts of the body that need it; person dies by suffocation.
- **CO_2** contributes to the greenhouse effect which has been linked to global warming / climate change. It causes heat energy to be reradiated back to earth and subsequently global warming occurs.

Methanol Synthesis:

(1) $CH_4 + H_2O \rightarrow CO + 3H_2$; this is steam reforming. Methane is reacted with steam to produce CO and H_2.
(2) $CO_2 + H_2 \leftrightarrow CO + H_2O$; this is the water-gas shift reaction; it adjusts the amount of H_2 in the reactor.
(3) $CO + 2H_2 \rightarrow CH_3OH$; CO & H_2 make up the "synthesis gas" which reacts over a copper catalyst to make methanol.

Conversion reactions are never 100 percent efficient and leftover unreacted gases are recovered and re-processed. Methanol has many uses including being used in recyclable plastic bottles, pharmaceuticals, polyester, paint, glues, foams and solvents, as well as being about 10% of methylated spirits.